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IMPROVING THE ABILITY TO READ ARITHMETIC PROBLEMS

ESTALINE WILSON
Assistant Superintendent of Schools, Toledo, Ohio

It is generally understood by teachers that much of the failure on the part of pupils to solve arithmetic problems is due to poor reading and the consequent inability to understand the problems. In an effort to overcome this difficulty, pupils have been told to "read the problem carefully." This has meant "read the problem orally," or "read the problem over again." Sometimes the teacher feels it necessary to read the problem to the pupils.

If the standards which obtain in the reading classes were applied to the reading of arithmetic problems, the resort to reading aloud would not be a matter of so much concern; but the reading of problems is seldom good reading. Both pupils and teachers are satisfied when the words have been called in a meaningless fashion, the major emphasis being on calling out the numbers.

Investigations in other subjects have shown that frequently individuals who read orally with apparent facility comprehend only a small part of the material which they read. If pupils are questioned regarding the simplest statements in arithmetic problems they have just read, it will commonly be found that they have been merely pronouncing empty words. This is much more frequently observed in arithmetic than in geography and other subjects employing ordinary narrative material.

The special situation in the case of arithmetic is no doubt often due in part to the fact that the wording of the problem is obscure; but this is not the whole explanation, because the same difficulties are often noted where the wording is perfectly clear. The more probable explanation is that pupils feel very little responsibility for knowing what they are reading, apart from the numbers involved.

In not a few cases the first real attention to careful reading on the part of the pupil is when he is called upon to explain a problem to the class. When pupils who have read and studied a problem laboriously are called upon to "explain" the method of solving it, they are seldom able to state the conditions of the problem without constant reference to the book. In story-telling or in history pupils are expected to read and to reproduce the story—and they can do it to the extent of pages of slowly moving narration—but three or four lines of the sort of reading which makes up the arithmetic problem are very seldom reproduced successfully. The difficulty lies apparently in the fact that teachers have not called upon pupils to master the story of the arithmetic problem; consequently pupils feel no responsibility for remembering any of the "reading" parts of the problem—they think it only necessary to show that they can figure successfully.

One of the reasons for this neglect of the story is that arithmetic problems are usually stripped of the details which make their reading vivid. The color, the style, and the material of a dress are quite as important to the purchaser as the price; but in an arithmetic problem a dress is a dress. A marble in a problem is a marble; but to the boy at play a marble is an agate, a "stony," or a "glassy."

Problems in books so often read: "If a man," etc., "Find the cost when," etc., and "At 6 cents for 25, what will 3 dozen articles cost?" This flat impersonal form of expression has no doubt grown out of the necessity of providing enough problems in a book to supply the needed drill; but it works disaster in the training of pupils. Once we become aware of the dull and meaningless character of arithmetic reading, we realize that we are confronted with two important questions: (*a*) To what extent can we aid pupils to comprehend the real situation which is involved in the problem? (*b*) To what extent can fluent and correct reading contribute to the actual solving of the problem?

The first step in teaching pupils to read problem-material is one of making the story in the problem so real and so vivid that the pupil realizes the situation. Several means of specific training in the reading of problems were suggested to teachers in some of the schools of Cincinnati. Those methods which have been tried out sufficiently to be evaluated are explained somewhat in detail.

Teachers were advised to have pupils study the problems just as they would any lesson—that is, with the idea of getting the thought of the reading regardless of the figures. To this end, the teacher placed on the board questions that would aid the pupils in determining the meaning of the problems, just as she wrote questions that would aid them in interpreting a story from the reader. Sometimes the pupils themselves suggested questions with the same intent. An example of a problem with appropriate questions will illustrate the method.

James sold 36 copies of the *Saturday Evening Post* at 5 cents each. He kept ⅔ of the money. With the remainder he bought daily papers at ¾ cents each. How many did he buy?

1. How could you find out how much James would have after he sold his copies of the *Post?*
2. What part of his money did he spend for daily papers?
3. What part did he keep? What did he probably do with his money?
4. Why do you think he did not spend it all for more papers?
5. How did the cost of a daily paper compare with the cost of a *Post?*
6. If you know how much money he spent for daily papers and the cost of each one, how will you find how many he could buy?

Again, the pupils used the mere facts of the problem as a plot of a story. They read between the lines and supplied the details which made the problem real. They changed dull facts about buying and selling sugar into fanciful tales of lemonade stands.

Such a problem as "What was the cost of 6 pounds of sugar at 8 cents a pound, 6 cans of milk at 5 cents a can, and 2 dozen eggs at 30 cents a dozen?" becomes for Louise a shopping situation in which her mother wants to bake a cake—unexpected guests—Louise must make a hurried expedition to the corner grocery. Her mother needs three things—eggs, milk, and sugar. She says them over and over on the way so as not to forget the important items. The grocer quotes prices as she buys each article. "Eggs are 30 cents today; sugar is down to 8 cents a pound," etc. She gets home and reports to her mother the total expenditure, and her mother, in turn, counts up to see if Louise has figured the problem correctly.

To another pupil the same figures suggest a very different situation. The scout team plans a hike. Bill's part of the "eats" consists of sugar and milk for the cocoa and eggs to fry over a camp fire. Each scout is to present his bill in order that all may share equally the total cost. So Bill figures up carefully the cost of the sugar, eggs, and milk, and presents his bill in a business-like manner to his scout master.

Once the pupils catch the spirit of reading into the facts the interesting situation which may be involved and of reading into the same number-relations many situations which require the same use of figures, they "make up stories" rapidly and with great enthusiasm. That pupils manifest such interest in this manner of dealing with written problems is not suprising, for this is probably the sort of thing which goes on in the minds of many of them whenever they solve problems. The really surprising thing is that there are many who cannot do it—many for whom figures are quite apart from situations.

In another class the situations of the problem were dramatized. In reading the problems, the pupils were to think how they could act out the story of the problems. A few minutes were allowed for this, preliminary to the actual solving of the problems. Thus, the scenes shifted rapidly from an automobile show, where an enthusiastic salesman greeted Farmer Jones and his family, showed him various cars, quoted the discounts, and glibly figured for him the savings the various percentages represented, to a hat shop where customers called for the bargains they had seen advertised in the newspapers.

Gradually, as the situations became more significant, problems were read as the reading lessons where the quantitative measure was completely ignored. The problem would then read in some such way as this: How many badges of a certain length can be cut from a piece of ribbon so long? Such a problem was acted in pantomime, the members of the class identifying the problem from the motions of the pupil acting it. The pupils themselves proposed numberless situations which could be made into arithmetic problems. "We have just so many health buttons to distribute among a certain number of rooms. How many can each room have?"

What was the effect of these reading devices? Three of the methods indicated were used separately by teachers with some effort to measure the results in terms of improved ability to solve problems. In a sixth-grade group, composed largely of pupils whose intelligence quotients were relatively low, the teacher gave the Stone Reasoning Test as the initial measure. For a period of five weeks she devoted ten minutes three times a week to the reading of problems, using the question method as described earlier in this article. At the end of this period the pupils were given the reasoning test a second time. The resulting improvement of a large percentage of the pupils and the raising of the class averages from below to above standard seem satisfactory returns for the time spent in problem work. While it is impossible to determine exactly the extent to which the specific training in reading is responsible for the improvement shown, the teacher believes it contributed very largely thereto, since she practically confined explanation to the making and answering of questions in the preliminary reading and to very simple acting-out of the problems where the questions failed to make the situation vivid. The records for the two tests are shown for the boys and girls separately in Tables I and II.

TABLE I

IMPROVEMENT IN SCORES OF SEVENTEEN SIXTH-GRADE BOYS ON STONE REASONING TEST

Pupil	Intelligence Quotient	Test Score	
		April 4	May 11
1	94	4.0	5.0
2	84	6.6	6.0
3	72	2.0	5.6
4	77	4.0	5.4
5	61	5.4	6.6
6	72	3.0	1.0
7	82	6.2	8.8
8	75	6.6	5.6
9	99	3.2	8.6
10	87	7.8	8.0
11	117	6.8	7.2
12	90	2.0	6.6
13	81	9.0	9.2
14	83	6.6	8.0
15	*	8.4	8.9
16	83	5.6	9.2
17	92	7.6	6.6
Standard for sixth grade		6.5	6.5
Average for group		5.5	6.8
No. above standard		8	11
No. below standard		9	6

* Not in school for test.

In a second school, after the teacher had developed with the class a skilful technique in the making of stories from the problems, she tried to evaluate the effect of the time spent in this preliminary reading of the problems in terms of the increased ability to solve the problems. A set of problems was put on the board and the pupils were told to solve them, no preliminary reading or story-making being permitted. The following day the pupils were allowed to read the problems and make them into stories. They were then told to solve the same list. The class median showed an increase in rate of 14 per cent and in accuracy of 30 per cent.

TABLE II

IMPROVEMENT IN SCORES OF SEVENTEEN SIXTH-GRADE GIRLS ON STONE REASONING TEST

Pupil	Intelligence Quotient	Test Score	
		April 4	May 11
1	69	2.0	2.6
2	71	4.0	5.0
3	77	1.0	2.0
4	89	3.0	4.4
5	81	5.0	6.4
6	62	4.0	5.2
7	98	6.4	7.6
8	92	2.0	3.6
9	79	6.0	5.0
10	75	3.0	2.6
11	81	4.0	8.4
12	60	2.0	3.0
13	92	3.0	3.0
14	83	5.4	6.4
15	113	7.0	7.8
16	77	5.0	7.0
17		3.0	6.0
Standard for sixth grade		6.5	6.5
Average for group		3.8	5.1
No. above standard		1	4
No. below standard		16	13

Of course, the second solving had, in addition to the specialized making of stories, the advantage of the original reading where there was no aid given. It would seem, however, that if the class developed a technique of reading which resulted in an increase of 30 per cent following one reading period, the time was well invested. Further evidence of the effectiveness of the method with this group is shown by their very high score on the Monroe Standard

Reasoning Test which was given after they had been working on this particular reading plan for some time, the class score for "correct principle" being 32 as compared with the standard score of 17; for "correct answer" the class scored 17, the standard being 9.7.

A third plan, involving both story-telling and dramatization, was tried in an opportunity class containing twenty children. Of the nineteen of this group who had been given mental tests, eight were found to have an I.Q. between 80 and 90, six between 70 and 80, and five between 60 and 70.

The initial test was the Progress Test in Arithmetic by Peet and Dearborn and was given before there had been any special training in the reading of problems. The same test was repeated, no mention of the test having been made in the interim, following a period of six weeks in which the pupils spent approximately ninety minutes a week in solving problems, always after a careful preliminary reading. The results of the two tests showed an improvement for the group from a median score of 28 on the first test to 72 on the second.

The teachers of these classes say that the various plans have added interest to the solving of arithmetic problems. From the point of view of arithmetic, these methods supply a sufficient variety of uses of the same number-relations finally to develop the abstract notion of the quantitative side of a situation. The various reading methods, the ones mentioned here together with others which could be used, also offer a substitute for the formal reading so generally employed which tends to make the reading of the problem a mere matter of routine without requiring of the pupils that they comprehend the real significance of the conditions of the problem.

It is obvious that these attempts to evaluate a method of teaching pupils to read arithmetic problems have not been employed extensively enough to make the evidence conclusive, but it does seem to point to the possibility of doing in arithmetic what we have done in the case of silent reading of other material—developing a variety of devices which will aid in giving effective training for the special type of ability involved in reading problem material.